Low Energy Water Treatment Technology Challenge Program Guide

Introduction

The Low Energy Water Treatment Technology Challenge seeks improvement to existing or new low energy solutions for the treatment of dissolved organic compounds present in Oil Sands Process Water (OSPW) at oil sands mining operations without producing any new residual streams requiring further treatment or disposal.

To date, no treated OSPW has been released back to the Athabasca river even though oil sands mines have been operating for more than 50 years. This imbalance has resulted in either building inventories and/or increasing salination of OSPW due to increased recycle rates and reduced use intensity. Delaying treated OSPW release further will postpone reclamation of mine sites for decades, thus underlining the need for innovative treatment technologies.

Background

Oil sands contain approximately 6% to 15% bitumen and 80% to 85% mineral solids (by weight), with water making up the balance. To extract bitumen in surface mining operations, OSPW is heated and mixed with oil sands to separate the bitumen from the mineral solids. The bitumen is floated and the tailings (a mixture of water, sand, silt, clay, and some unrecovered bitumen) are deposited in tailings storage. The overall process is approximately 80% to 85% efficient. (See Appendix 1 for additional background information).

Low Energy Water Treatment Technology Challenge - Overview

The Low Energy Water Treatment Technology Challenge seeks improvement to existing or new technologies to treat dissolved organic compounds present in OSPW, thereby improving environmental performance in the mineable oil sands industry. Technologies should not produce any new residual streams requiring further treatment or disposal.

The successful technology will:

- Work in a Northern Climate.
- Be a low energy system requiring little or no operator or maintenance interaction.
- Be able to treat 1.5 – 30Mm^3/year of OSPW (mean flow: 0.05 – 1 m^3/sec. Peak flow: 1 to 30 m^3/sec).
- Produce a treated effluent with the quality specified in Appendix 2.
- Meet the following key treatment effluent parameters:
    - Be acutely nontoxic as per Oncorhynchus mykiss (rainbow trout) 96 h test.
    - Remove sufficient acid extractable organics such that i t passes the acute bioassays

(See Appendix 2 for influent and effluent parameters.)

Generally the proposed technologies will be of two types:

1. Once through treatment, in which the treated water meets the discharge requirements following treatment (See Figure 1).

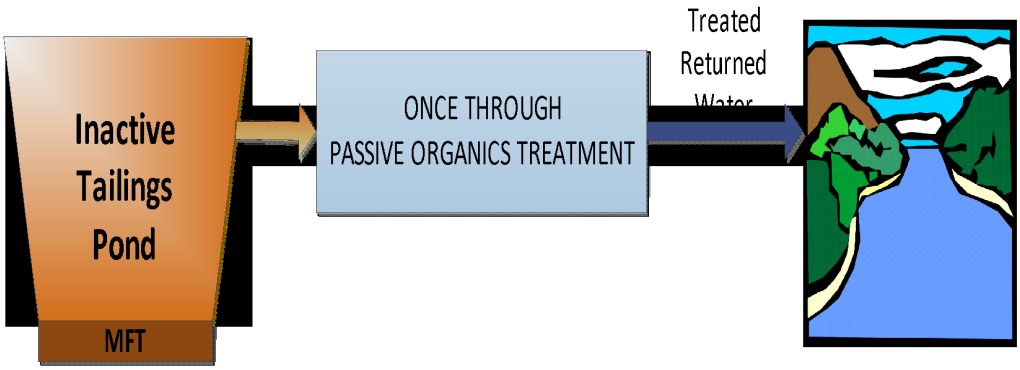

Figure 1: Once through treatment (MFT = Mature fine tailings).

2. In Pond Treatment in which the treatment technology occurs in/ or adjacent to the pond, and gradually improves the water quality until the quality of the entire water body is sufficient that the water can be returned to the Athabasca River (See Figure 2).

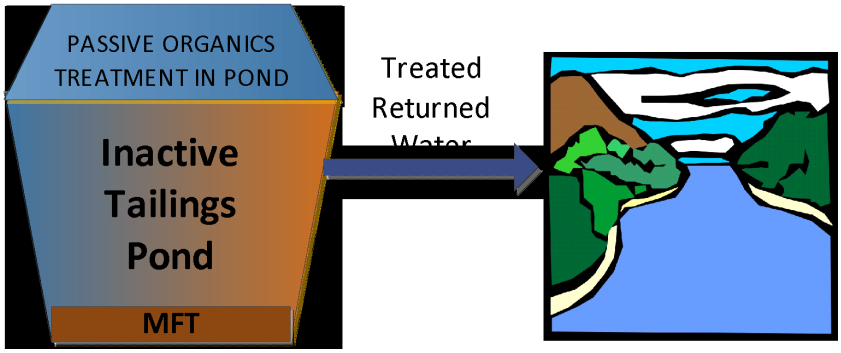

Figure 2 – In Pond Treatment

The following approaches are **not of interest**:

- Approaches that have not demonstrated proof of concept.
- Mechanical treatment that requires significant energy inputs and routine operator interaction such as ozonation.
- Studies which focus only on chemical analysis and organics speciation. Any analytical work must be coupled with a proposed treatment technology.
- Adsorption – if not self-regenerating.
- High energy technologies such as desalination techniques using membranes.

Challenge Outcomes

Successful proposals can receive funding from Canada's Oil Sands Innovation Alliance (COSIA) members to develop and demonstrate the technology in an oil sands application. Multiple technologies may be funded, at the discretion of the Members.

Timeline

The Challenge will be open for a period of nine weeks. Key dates of the Challenge are provided below.

Eligibility

To be considered, solutions must:

- Be at a Technology Readiness Level (TRL) of 4+

Solutions below TRL 4 will be considered if there is a compelling description of the solution's potential

Evaluation Criteria

All eligible and complete submissions will be evaluated by a panel of technical experts on the following key success indicators:

- Minimal energy needs
- Low capital and operating costs
- Ability to operate at ambient conditions (temperature, other operating environment restrictions)
- Little or no residuals produced requiring further treatment and/or disposal

About the Challenge partners

Canada's Oil Sands Innovation Alliance (COSIA) is a unique alliance of oil sands producers focused on accelerating environmental performance in Canada's oil sands. COSIA enables collaboration and innovation between thinkers from industry, government, academia and the wider public to improve measurement, accountability and performance in the oil sands across four environmental priority areas of Greenhouse Gases, Land, Water, and Tailings. COSIA members search the world for solutions to our toughest problems.

Dr. Mohamed Gamal El-Din is the NSERC Senior Industrial Research Chair in Oil Sands Tailings Water Treatment and a Professor in the Department of Civil and Environmental Engineering at the University of Alberta. Dr. Gamal El-Din has an active research program in the area of oil sands tailings water treatment. The goal of this research area is to provide not only innovative treatment and reclamation approaches to protect environmental and public health, but also to facilitate water reuse and/or the safe discharge of treated process water into the receiving environment while ensuring the environment and human health are protected.

COSIA's Water Environmental Priority Area (EPA) and Dr. Gamal El-Din have formed a research partnership to help COSIA realize its water aspiration: to be world leaders in water management, producing Canadian energy with no adverse impact on water.. Together, they have identified a need for technologies to passively treat dissolved organic compounds present in Oil Sands Process Water (OSPW).

Terms and Conditions

Registration and application submission

In order to participate, applicants must register on the Challenge website. Once registered, applicants must complete the Application Form in full. All applications must be in English, and must adhere to the requirements specified in the various sections of the online form (including the requisite attachments to support the submission). Applications not respecting the requirements may be rejected.

The deadline for submitting applications is **11:59pm PT, January 16, 2023**. All applications must be submitted through the Challenge's application platform. Any submissions sent to the Challenge mailbox or made after the deadline will not be accepted. Applicants are encouraged to complete their submissions well in advance of the deadline. Partial or incomplete submissions will not be eligible for review. All required content must be uploaded and entered into the Challenge platform, and the submission must be finalized by completing all necessary online steps in order for the application to be considered complete before the deadline. Only the specified information requested in each section of the application will be reviewed. Any links to additional material or information submitted outside of the application form will not be considered during the evaluation. Applicants will receive an email confirming receipt of a complete submission.

Project specific feedback will not be provided for unsuccessful applicants.

Intellectual property

Proprietary information belonging specifically to the manufacturer/solution provider will not be shared outside of the project team. Only information that is required for the evaluation of submissions or other necessary competition functions will be shared within the project team.

Confidential information that is collected, used, or disclosed by Foresight will be handled in a manner that recognizes both the right of the individual to have their confidential information protected and the need of Foresight to collect, use, and disclose such information for the purposes of determining the Challenge winners and ensuring a fair process.

Contact

If you have any questions regarding this Challenge, please send them to:
challenges@foresightcac.com

Appendix 1: Additional Background Information

Oil sands are compacted deposits of sand, silt, clay, water and bitumen. In general, they contain by weight about 6 to 14% bitumen, and 80 to 85% mineral solids with water making up the balance. Raw bitumen is produced either by mining/extraction methods or by in-situ techniques using wells to recover the bitumen. For mining operations, imported river water that is not evaporated or chemically consumed is contained on-site within tailings structures to become part of the OSPW inventory. This water is primarily used for bitumen extraction, cooling and material transport.

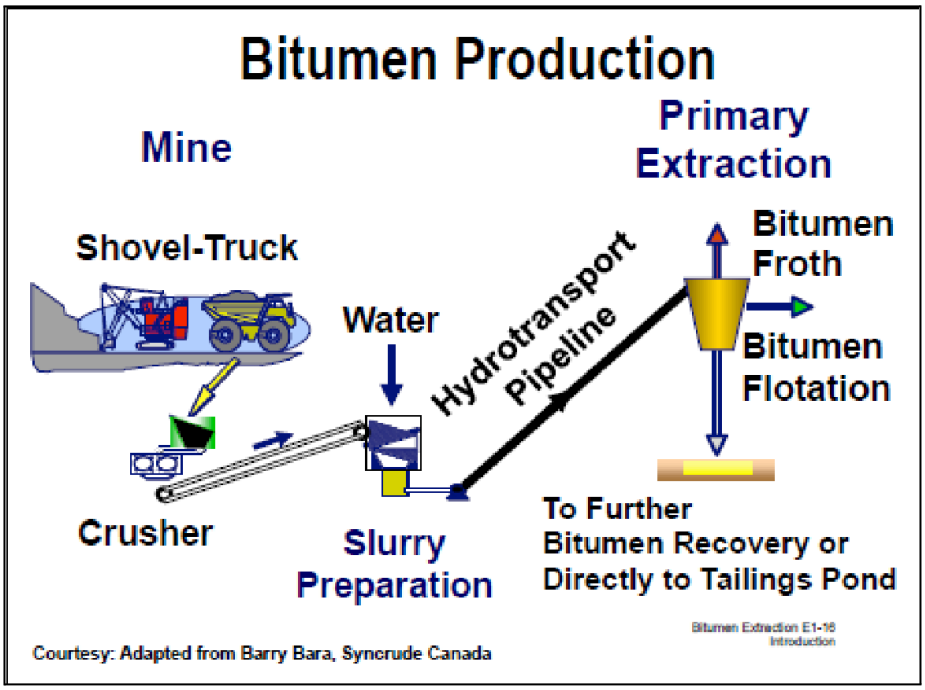

Figure 3: Typical Bitumen Production Process Schematic

To extract bitumen in surface mining operations, OSPW is heated and mixed with oil sands to separate the bitumen from the mineral solids. The bitumen is floated and the tailings (mixture of water, sand, silt, clay, and some unrecovered bitumen) are deposited in tailings storage. Tailings storage areas have three main features:

- A sand beach which also contains some fines (i.e., particles < 44 micron in size) and OSPW

- Fluid fine tailings (FFT) made up of 20-40% fines with the balance being OSPW
- A cap layer of OSPW.

The cap layer or free water zone in the ponds is reused in the extraction process. The overall process is approximately 80-85% efficient. The 15 to 20% water loss is attributable to that portion that evaporates or becomes pore water within the FFT, sand beaches and dykes. This challenge statement is focused on low energy treatment of the organic components present in OSPW. Typically applications include closure of tailings structures and expediting aquatic reclamation using pit lakes.

Pit lakes are former in-pit tailings facilities that will become a permanent reclaimed aquatic feature in the closure landscape. Typically, these lakes consist of a layer of OSPW and/or Athabasca River water overlying a treated tailings deposit. Surface water will be supplied by the surrounding watershed and, over time, the outflow will report to the environment. Research efforts to date demonstrate that these lakes will evolve into natural ecosystems and over time support healthy communities of aquatic plant, animals and fish.

Common Misconceptions

1. Tailings ponds need to be completely eliminated.

   During the active life of an oil sands mine they are an integral part of the process.

2. Pit Lakes are not effective reclamation tools.

   Pit lakes are an integral part of the closure landscape for all mining sectors including oil sands.

3. Better Oil Water Separation technologies are needed to treat OSPW.

   While improved oil water separation is always welcome the current technologies separate oil and water quite well, as a result oil water separation is not a limiting factor for oil sands environmental performance

Additional Resources:

COSIA 2020 Mining Research Report (pg 68 to 108 – Treatment Technologies)

COSIA 2021 Water Mining Research Report (pg 54 to 100 – Treatment Technologies)

Appendix 2: Influent and Effluent Range Data

Parameter	Unit	Influent Range	Treated Return Water Design Basis
Average Flow	Mm3/year	0.5-5	0.5-5
Average flow	m^3/sec	0.05 – 1	0.05-1
Peak Flow	m^3/sec	1 – 30	1-30
Temperature	°C	4-21	4-21
pH		7.5-8.8	6.5-8.5
BOD_5	mg/L	4-320	2-20
COD_{Total}	mg/L	175-650	See below toxicity
TOC	mg/L	40-250	See below toxicity
DOC	mg/L	30-120	See below toxicity
TSS	mg/L	20-800	<25
TDS	mg/L	1200-3000	Treatment not required
Alkalinity	mg/L as $CaCO_3$	600-900	Treatment not required
Hardness	mg/L as $CaCO_3$	40-120	Treatment not required
O&G	mg/L	5-150	<10
Ammonia	mg/L	0.0076-30	See below toxicity
Phenols	mg/L	0.0036- 0.0270	See below toxicity
PAHs	mg/L	0.0004-0.015	Treatment not required
Acid extractible organics	mg/L	15-80	See below toxicity
BTEX	mg/L	0.01-5	See below toxicity
Arsenic	mg/L	0.0033-0.05	
Cadmium	µg/L	0.00006-0.4	

Chromium	mg/L	0.0005-0.04	Treatment not required
Copper	mg/L	0.0001-0.03	
Lead	mg/L	0.0001-0.04	
Mercury	µg/L	0.0005-0.2	
Nickel	mg/L	0.005-0.04	
Selenium	mg/L	0.0009-0.15	
Strontium	mg/L	0.31-0.8	
Vanadium	mg/L	0.001-0.05	
Zinc	mg/L	0.002-0.35	
Toxicity			● Acutely nontoxic as per *Oncorhynchus mykiss* (rainbow trout) test. ● Sufficient removal of the acid extractable organics such that it passes the acute bioassays.